WEBVTT

1 00:00:02.790 --> 00:00:05.230 - Alright, I think we should start,

2 00:00:05.230 --> 00:00:06.920 so welcome everyone

3 00:00:06.920 --> 00:00:10.200 and welcome to our fourth,

4 00:00:10.200 --> 00:00:14.808 the first seminar of the Yale Center on Content

5 00:00:14.808 --> 00:00:17.630 in House in for 2020,

6 00:00:17.630 --> 00:00:22.630 and so today we are very please that you have dr. Xuhui Lee

7 00:00:24.800 --> 00:00:27.080 from the Yale School of Environment.

8 00:00:27.080 --> 00:00:31.540 So he's the Sara Shallenberger Brown

9 00:00:31.540 --> 00:00:33.730 Professor of Meteorology,

10 00:00:33.730 --> 00:00:37.310 he's also a director of the Yale Center

11 00:00:38.490 --> 00:00:39.790 for The Earth Observation,

12 00:00:40.650 --> 00:00:44.510 he also received the 2015 award

13 00:00:44.510 --> 00:00:48.530 for outstanding achievement in Balm meteorology

14 00:00:48.530 --> 00:00:52.230 from the American Meteorological Society.

15 00:00:52.230 --> 00:00:54.827 So without further ado,

16 00:00:56.780 --> 00:00:59.150 we will have doctors. Xuhui Lee

17 00:01:01.410 --> 00:01:02.480 - Thank you, Kai

18 00:01:02.480 --> 00:01:07.480 and also thank you Rob for having me in this event.

19 00:01:09.160 --> 00:01:14.160 Let me see, how do I, can you see my screen Okay?

20 00:01:15.140 --> 00:01:16.250 - Yes.

21 00:01:16.250 --> 00:01:17.083 Okay good.

22 00:01:18.270 --> 00:01:23.040 So I'm gonna go talk about some of all the work done

23 00:01:23.040 --> 00:01:24.643 on Urban Heat Island.

24 00:01:25.800 --> 00:01:27.500 Let me see if we can turn out the,

25 00:01:30.170 --> 00:01:35.170 so the title of my talk is Urban Heat Island Theory

26 00:01:35.790 --> 00:01:40.570 Measurement and Mitigation.

27 00:01:40.570 --> 00:01:41.880 So somewhere in that order,

28 00:01:41.880 --> 00:01:44.960 let me see if I can turn off my screen here.

29 00:01:44.960 --> 00:01:46.390 Okaynow, that's much better

30 00:01:48.113 --> 00:01:51.300 and so the work I'm presenting today

31 00:01:51.300 --> 00:01:55.230 is really a collection of things done by folks

32 00:01:55.230 --> 00:02:00.230 in my lab, current members and also past members so far

33 00:02:01.660 --> 00:02:05.660 of my lab, some of them are actually attending this event

34 00:02:06.760 --> 00:02:09.930 and I noticed that this event is being recorded,

35 00:02:09.930 --> 00:02:10.890 that's fine with me.

36 00:02:10.890 --> 00:02:15.080 There are a few slides where we don't have where we can....

37 00:02:15.080 --> 00:02:17.660 Where I showed you a sort of unpublished results

38 00:02:17.660 --> 00:02:20.820 so if you'd like to, if you want to share this recording

39 00:02:20.820 --> 00:02:23.790 with folks, please refrain from perhaps

40 00:02:23.790 --> 00:02:26.853 not sharing that part to people.

41 00:02:32.100 --> 00:02:34.820 So many of you are familiar

42 00:02:34.820 --> 00:02:36.330 with this kind of projections right?

43 00:02:36.330 --> 00:02:38.750 Projecting for temperature into the future

44 00:02:38.750 --> 00:02:40.370 to the end of the century

45 00:02:40.370 --> 00:02:45.370 depending on whether we take the aggressive mitigation

46 00:02:46.000 --> 00:02:48.880 or scenario or more of a business as new your scenario

47 00:02:48.880 --> 00:02:52.490 we will end up with very different temperature projection

48 00:02:52.490 --> 00:02:54.810 in the low emissions scenario,

49 00:02:54.810 --> 00:02:58.880 we expect maybe 1.5 degrees of increase, decrease dialysis

50 00:02:58.880 --> 00:03:01.240 increase near the end of the century

51 00:03:01.240 --> 00:03:06.240 but in a more sort of aggressive emission scenario RCP 8.5,

52 00:03:08.310 --> 00:03:13.310 the projection is that four degrees of decreases of warming

53 00:03:13.620 --> 00:03:15.750 towards the end of the century.

54 00:03:15.750 --> 00:03:18.670 So that's the kinda big picture.

55 00:03:18.670 --> 00:03:21.650 So what I would argue is that Heat stress

56 00:03:21.650 --> 00:03:23.420 is actually perhaps the most,

57 00:03:23.420 --> 00:03:26.800 the biggest climate threat to humans

58 00:03:26.800 --> 00:03:29.480 in stress associated with climate change.

59 00:03:29.480 --> 00:03:30.810 The reason is simple

60 00:03:30.810 --> 00:03:33.780 that we humans are warm blooded animals,

61 00:03:33.780 --> 00:03:37.880 We have a biological limit we cannot overcome,

62 00:03:37.880 --> 00:03:39.600 so we are warm blooded,

63 00:03:39.600 --> 00:03:43.470 we keep our body temperature at a constant value

64 00:03:43.470 --> 00:03:46.340 of the property 37 degrees Celsius

65 00:03:46.340 --> 00:03:48.860 and in a warm climate we need to maintain

66 00:03:48.860 --> 00:03:52.640 a temperature differential of at least two degrees

67 00:03:52.640 --> 00:03:55.660 between the thick body and the skin

68 00:03:55.660 --> 00:03:57.220 in order to for the metabolic heat

69 00:03:57.220 --> 00:04:00.560 to get discredited in the environment right?

70 00:04:00.560 --> 00:04:02.960 So that's a physiological limit barrier

71 00:04:02.960 --> 00:04:05.500 we cannot overcome if conditions

72 00:04:05.500 --> 00:04:07.880 in such that we cannot maintain

73 00:04:07.880 --> 00:04:11.220 a skin temperature lower than 35 degrees

74 00:04:11.220 --> 00:04:15.850 then we will suffer serious health consequences

75 00:04:15.850 --> 00:04:20.503 even death without of course the help of air conditioning.

76 00:04:21.786 --> 00:04:24.330 So that's the kind of the motivation

77 00:04:24.330 --> 00:04:25.800 for this kind of work off

78 00:04:25.800 --> 00:04:28.560 and of course we know that residents

79 00:04:28.560 --> 00:04:31.160 in the Urban Environment,

80 00:04:31.160 --> 00:04:35.020 urban residents suffer an additional Heat stress

81 00:04:35.020 --> 00:04:36.370 due to the Urban Heat Island.

82 00:04:36.370 --> 00:04:38.130 This is sort of classic depiction

83 00:04:38.130 --> 00:04:41.890 by Jumoke of what an urban heat Island looks like.

84 00:04:41.890 --> 00:04:43.470 If you have a bicycle for example

85 00:04:43.470 --> 00:04:46.800 your attach or sensor, something I would talk about it,

86 00:04:46.800 --> 00:04:48.790 you'd end up with this lecture

87 00:04:48.790 --> 00:04:53.790 and you move across a transect from rural to urban core.

88 00:04:56.280 --> 00:04:59.700 You would record temperature variations such way

89 00:04:59.700 --> 00:05:02.523 lower temperature in outside city,

90 00:05:02.523 --> 00:05:05.550 as you move to the center of city

91 00:05:05.550 --> 00:05:08.440 yo'll register very high temperature

92 00:05:08.440 --> 00:05:10.270 while relative to high temperature

93 00:05:10.270 --> 00:05:12.970 and this difference between urban

94 00:05:12.970 --> 00:05:15.940 versus rural temperature temperature

95 00:05:15.940 --> 00:05:17.330 is really what we call Urban Heat Island

96 00:05:17.330 --> 00:05:20.130 or intensity of therapy to time.

97 00:05:20.130 --> 00:05:24.020 So that's a well accepted sort of depiction

98 00:05:24.020 --> 00:05:25.570 of this phenomenon

99 00:05:26.761 --> 00:05:28.010 and so this is added heat

100 00:05:28.010 --> 00:05:30.744 that urban residents would experience,

101 00:05:30.744 --> 00:05:32.470 and this is a sort of spatial view

102 00:05:32.470 --> 00:05:33.950 for urban heat island here

103 00:05:33.950 --> 00:05:36.010 actually in the city of New Haven,

104 00:05:36.010 --> 00:05:38.300 the urban unite is very patchy.

105 00:05:38.300 --> 00:05:42.080 I have high spots here and there and some low spots there.

106 00:05:42.080 --> 00:05:47.050 So the high spots in the archaea shotguns area, right?

107 00:05:47.050 --> 00:05:49.010 And then that's this downtown area

108 00:05:49.010 --> 00:05:51.610 and then near the fringe of the city

109 00:05:51.610 --> 00:05:55.550 where you have a lot of trees, temperature is much lower.

110 00:05:55.550 --> 00:05:58.090 So that's the kind of urban heat island parent

111 00:05:59.219 --> 00:06:01.630 that you see in New Haven.

112 00:06:01.630 --> 00:06:05.090 So why Urban heat island is a concern?

113 00:06:05.090 --> 00:06:07.170 Well, you can just simply consider

114 00:06:07.170 --> 00:06:10.240 a probability distribution of temperature,

115 00:06:10.240 --> 00:06:12.010 this is a probability distribution temperature

116 00:06:12.010 --> 00:06:14.400 of maybe a rural background

117 00:06:14.400 --> 00:06:16.370 and Urban heat Island would shift

118 00:06:16.370 --> 00:06:18.970 this probability distribution just by a little bit,

119 00:06:18.970 --> 00:06:21.600 maybe by one degrees on average, right?

120 00:06:21.600 --> 00:06:24.500 But that one degree of shift in the mean

121 00:06:24.500 --> 00:06:28.090 would actually create a serious consequence

122 00:06:28.090 --> 00:06:31.140 in terms of heawave frequency

123 00:06:31.140 --> 00:06:34.490 and let's suppose the Heatwave threshold is here,

124 00:06:34.490 --> 00:06:36.040 now this is per heatwave threshold

125 00:06:36.040 --> 00:06:39.030 beyond which we will see problems

126 00:06:39.030 --> 00:06:40.740 with mobility and mortality

127 00:06:42.190 --> 00:06:46.010 and for Rural background, rural location,

128 00:06:46.010 --> 00:06:49.050 this is the area under this curve

129 00:06:49.050 --> 00:06:51.730 is your Heatwave frequency.

130 00:06:51.730 --> 00:06:56.290 Now for urban land, the simple shift in mean due to our heat

131 00:06:56.290 --> 00:06:59.620 on it, would change that frequency a lot,

132 00:06:59.620 --> 00:07:03.350 we increase that frequency a lot, right?

133 00:07:03.350 --> 00:07:05.460 And the other thing that you should notice

134 00:07:05.460 --> 00:07:07.770 of course as the urban heat Island,

135 00:07:07.770 --> 00:07:11.180 urban residents will actually experience

136 00:07:11.180 --> 00:07:14.780 a record temperatures not being seen by rural residents

137 00:07:14.780 --> 00:07:18.370 so again rural temperature stops here on,

138 00:07:18.370 --> 00:07:19.840 so this is a spread.

139 00:07:19.840 --> 00:07:22.490 So, but in the city,

140 00:07:22.490 --> 00:07:25.500 you will see temperature beyond the record, right?

141 00:07:25.500 --> 00:07:28.630 The record registering in the background sites.

142 00:07:28.630 --> 00:07:30.760 So that's also another issue

143 00:07:30.760 --> 00:07:34.053 that we should be concerned about Bob.

144 00:07:36.320 --> 00:07:39.480 So that is really the motivation

145 00:07:39.480 --> 00:07:43.870 for why we study the theory of urban heat island

146 00:07:43.870 --> 00:07:46.070 and why we want to come up with strategy

147 00:07:46.070 --> 00:07:49.550 to mitigate urban heat island, alright?

148 00:07:49.550 --> 00:07:51.510 So let me switch to give you

149 00:07:51.510 --> 00:07:53.780 a sort of review of theory

150 00:07:53.780 --> 00:07:56.160 of the urban heat island phenomenon.

151 00:07:56.160 --> 00:07:59.530 So this traits, they can be trace back to me many years ago

152 00:07:59.530 --> 00:08:01.510 to team Oaks textbook,

153 00:08:01.510 --> 00:08:05.160 in his textbook he listed the seven causes

154 00:08:05.160 --> 00:08:07.620 of urban heat Island of the seven,

155 00:08:07.620 --> 00:08:10.700 I highlight the four causes people consider it

156 00:08:10.700 --> 00:08:12.810 to be the major ones.

157 00:08:12.810 --> 00:08:14.780 The first one is increased absorption

158 00:08:14.780 --> 00:08:19.780 of short-wave radiation due to urban mophology

159 00:08:19.850 --> 00:08:23.270 and maybe due to the color of the landscape

160 00:08:23.270 --> 00:08:24.770 so they're committed...

161 00:08:24.770 --> 00:08:25.940 The conventional wisdom

162 00:08:25.940 --> 00:08:29.410 is that urban land tend to trap more solar radiation

163 00:08:29.410 --> 00:08:32.240 so that's a source of urban heat island.

164 00:08:32.240 --> 00:08:34.540 A second source of urban heat island of course

165 00:08:36.251 --> 00:08:37.980 is very easy to understand

166 00:08:37.980 --> 00:08:40.530 because there's an additional heat,

167 00:08:40.530 --> 00:08:43.540 anthropogenic heat from anthropogenic sources

168 00:08:43.540 --> 00:08:46.750 from automobile driving, driving automobiles bills,

169 00:08:46.750 --> 00:08:51.010 converts chemical energy in fossil fuel to mechanical energy

170 00:08:51.010 --> 00:08:53.470 that mechanical energy eventually dissipates

171 00:08:53.470 --> 00:08:55.710 as heat to the environment, right?

172 00:08:55.710 --> 00:08:57.110 And so another important source

173 00:08:57.110 --> 00:09:00.340 of anthropogenic heat is a space heating.

174 00:09:00.340 --> 00:09:04.570 We heat our houses or use of air conditioning

175 00:09:04.570 --> 00:09:06.290 and they will generate heat

176 00:09:07.820 --> 00:09:09.720 and dissipate heat to the environment.

177 00:09:11.080 --> 00:09:14.110 The third course is increased sensible heat storage

178 00:09:14.110 --> 00:09:19.110 on buildings and other facial structures can store energy

179 00:09:19.658 --> 00:09:23.730 solar energy, solar radiation energy in a daytime

180 00:09:23.730 --> 00:09:25.510 and that then they were released

181 00:09:25.510 --> 00:09:30.120 that energy at night causing nighttime urban warming,

182 00:09:30.120 --> 00:09:34.070 and finally not a major course is decreased evaporation

183 00:09:34.070 --> 00:09:36.690 You know that you'll replace natural vegetation,

184 00:09:36.690 --> 00:09:40.500 replacing, replace trees with artificial impervious surface

185 00:09:40.500 --> 00:09:43.260 you reduce evaporative cooling power right?

186 00:09:43.260 --> 00:09:44.400 So those are the four

187 00:09:44.400 --> 00:09:49.090 sort of major causes of Urban heat Island

188 00:09:49.090 --> 00:09:50.559 and so the, we understand

189 00:09:50.559 --> 00:09:52.920 those concepts in a conceptual way,

190 00:09:52.920 --> 00:09:55.930 in a qualitative way for a long time

191 00:09:55.930 --> 00:09:59.980 and so what we did was with a few years back

192 00:09:59.980 --> 00:10:04.570 was try to quantify those causes in a quantitative way.

193 00:10:04.570 --> 00:10:07.700 We believe, we know only by quantifying those causes

194 00:10:07.700 --> 00:10:11.010 that will then lay the foundation

195 00:10:11.010 --> 00:10:16.010 for sensible sort of measure of how to mitigate Binky Don.

196 00:10:17.510 --> 00:10:19.500 So I need to sort of take a step back

197 00:10:19.500 --> 00:10:22.580 and introduce this theory called

198 00:10:22.580 --> 00:10:27.470 The theory of intrinsic biophysical mechanism,

199 00:10:27.470 --> 00:10:29.440 this is theory was first developer to actually,

200 00:10:29.440 --> 00:10:34.440 to understand how perturbation changes surface temperature,

201 00:10:34.750 --> 00:10:37.690 changes near surface temperature amid arm,

202 00:10:37.690 --> 00:10:40.490 this theory is extended to talk,

203 00:10:40.490 --> 00:10:42.690 to the study of urban heat Island

204 00:10:42.690 --> 00:10:44.433 so some key points here.

205 00:10:45.420 --> 00:10:46.253 So this theory,

206 00:10:46.253 --> 00:10:49.095 This mechanism really is concerned with the process

207 00:10:49.095 --> 00:10:52.390 which how surface temperature responds

208 00:10:52.390 --> 00:10:55.850 to external perturbation by external perturbation,

209 00:10:55.850 --> 00:10:56.960 I mean a number of things.

210 00:10:56.960 --> 00:11:00.210 It could be addition additional aerosols to the atmosphere

211 00:11:00.210 --> 00:11:03.810 that will block sunlight penetration

212 00:11:03.810 --> 00:11:06.944 and an intercept sunlight penetration.

213 00:11:06.944 --> 00:11:11.944 And it could also be a change of urban, change of landscape

214 00:11:12.469 --> 00:11:15.950 a land use change replacing say, forest, we some open-end

215 00:11:15.950 --> 00:11:19.570 or natural land by urban man

216 00:11:19.570 --> 00:11:22.470 so those are considered to be external perturbation

217 00:11:23.670 --> 00:11:27.023 and so he helped Bob understand this process.

218 00:11:28.201 --> 00:11:31.650 There are two key components to that.

219 00:11:31.650 --> 00:11:35.630 Why is one called a local Longwave radiation feedback?

220 00:11:35.630 --> 00:11:39.260 And the other one is a change in energy redistribution

221 00:11:39.260 --> 00:11:42.410 but in the service in the overlaying atmosphere,

222 00:11:42.410 --> 00:11:46.800 I'm gonna explain those two processes in a little bit,

223 00:11:46.800 --> 00:11:50.780 so the way it quantified the surface temperature response

224 00:11:50.780 --> 00:11:54.290 is really just to do this sort of experiment

225 00:11:54.290 --> 00:11:55.770 or numerical experiment

226 00:11:56.860 --> 00:11:59.610 and then it goes quantified through measurement as well

227 00:12:00.840 --> 00:12:04.470 to the surface response really is the difference

228 00:12:04.470 --> 00:12:08.490 between temperature of old state before the perturbation

229 00:12:08.490 --> 00:12:10.430 and a new state after perturbation.

230 00:12:10.430 --> 00:12:13.000 So that's what the perturbation temperature signal

231 00:12:13.000 --> 00:12:16.913 is really the key here and we're trying to quantify.

232 00:12:18.270 --> 00:12:20.240 So let's take a look at,

233 00:12:20.240 --> 00:12:25.033 so let's go back to the case of deforestation study, right?

234 00:12:26.110 --> 00:12:28.790 The interest here is motivate your part

235 00:12:28.790 --> 00:12:33.160 by the new trying to send whether removing trees

236 00:12:33.160 --> 00:12:38.160 or adding trees or warm or cool the local temperature.

237 00:12:38.420 --> 00:12:41.423 So I, this is my favorite numerical example.

238 00:12:42.640 --> 00:12:47.640 This is a actual data collected over forest in Israel,

239 00:12:47.640 --> 00:12:49.530 semi arid climate conditions.

240 00:12:49.530 --> 00:12:52.890 This is how much solar energy reaches the forest

241 00:12:52.890 --> 00:12:54.490 and this is how much get reflected

242 00:12:54.490 --> 00:12:59.490 through its albedo reflected away from the surface,

243 00:12:59.530 --> 00:13:03.750 some escape of course to outer space,

244 00:13:03.750 --> 00:13:05.400 this is just a top of atmosphere.

245 00:13:06.260 --> 00:13:08.330 Now if you remove the forest

246 00:13:08.330 --> 00:13:10.513 and replace for us with some Shrub land,

247 00:13:11.590 --> 00:13:14.910 shrub land is much brighter, has higher albedo

248 00:13:15.940 --> 00:13:17.930 and so it's a short wave radiation

249 00:13:17.930 --> 00:13:22.310 well reflection will increase

250 00:13:22.310 --> 00:13:24.397 and so naturally you would think

251 00:13:24.397 --> 00:13:25.510 that the temperature would go down, right?

252 00:13:25.510 --> 00:13:26.760 Because now you have more

253 00:13:26.760 --> 00:13:31.760 or less short wave trapping solar radiation

254 00:13:32.150 --> 00:13:34.160 and so when the surface

255 00:13:34.160 --> 00:13:37.580 when we undergo what we call radiative feedback

256 00:13:37.580 --> 00:13:42.270 because when you have low absorption solar radiation,

257 00:13:42.270 --> 00:13:45.700 the surface cool and therefore they will have

258 00:13:45.700 --> 00:13:49.080 less Longwave radiation escaping to the from surface

259 00:13:49.080 --> 00:13:50.810 and eventually you will establish

260 00:13:50.810 --> 00:13:53.660 a new radiation liberate, right?

261 00:13:53.660 --> 00:13:56.980 Cause that process, the longwave adjustment,

262 00:13:56.980 --> 00:14:00.770 it's called Longwave feedback, that's a negative feedback

263 00:14:02.280 --> 00:14:06.720 and so if you allow just Longwave a radiation exchange,

264 00:14:06.720 --> 00:14:09.621 only allow radiation exchange to occur

265 00:14:09.621 --> 00:14:12.970 between the surface and atmosphere,

266 00:14:12.970 --> 00:14:15.550 this is you can come up with a simple prediction

267 00:14:15.550 --> 00:14:19.730 So the change of straight away radiation is dead ass

268 00:14:19.730 --> 00:14:21.730 that's your perturbation signal

269 00:14:21.730 --> 00:14:24.290 and the change of surface temperature Delta Ts right?

270 00:14:24.290 --> 00:14:27.790 This is a parameter called Local climate sensitivity,

271 00:14:27.790 --> 00:14:29.687 that's more or less a constant the number

272 00:14:29.687 --> 00:14:32.510 and so in this particular numerical example

273 00:14:32.510 --> 00:14:36.567 you would predict by replacing for us Shrub land

274 00:14:36.567 --> 00:14:40.300 and you expect a coin of dot four degrees

275 00:14:40.300 --> 00:14:42.270 about five degrees, right?

276 00:14:42.270 --> 00:14:45.600 So that's an argument some people used

277 00:14:45.600 --> 00:14:48.350 to promote deforestation,

278 00:14:48.350 --> 00:14:51.310 they're saying deforestation actually maybe a good thing

279 00:14:51.310 --> 00:14:55.000 cause helps cool the local climate

280 00:14:56.230 --> 00:14:58.470 because a lot because of albedo effect,

281 00:14:58.470 --> 00:15:00.740 but of course that picture is not complete

282 00:15:00.740 --> 00:15:02.970 because in the real world,

283 00:15:02.970 --> 00:15:06.480 you not only how a radiative process irradiated feedback,

284 00:15:06.480 --> 00:15:10.860 you also have too what I called energy redistribution

285 00:15:10.860 --> 00:15:13.983 occurring between the surface and the atmosphere.

286 00:15:15.125 --> 00:15:16.120 So there are two processes;

287 00:15:16.120 --> 00:15:17.900 One is evaporation.

288 00:15:17.900 --> 00:15:19.100 Evaporation is a process

289 00:15:19.100 --> 00:15:23.130 where liquid water is converted to water vapor right?

290 00:15:23.130 --> 00:15:25.480 So that happens near, at the surface.

291 00:15:25.480 --> 00:15:28.270 so evaporation that will take away energy,

292 00:15:28.270 --> 00:15:31.280 take away late night Tiki damage that will consume energy

293 00:15:31.280 --> 00:15:33.700 and then when vapor gets to the top

294 00:15:33.700 --> 00:15:35.640 above the atmospheric boundary layer

295 00:15:35.640 --> 00:15:37.390 and condenses to form cloud,

296 00:15:37.390 --> 00:15:39.990 that energy latent heat get released.

297 00:15:39.990 --> 00:15:43.710 So the process is a process of energy redistribution.

298 00:15:43.710 --> 00:15:46.430 It reduced screwed energy, taking away energy away

299 00:15:46.430 --> 00:15:48.880 from the surface, and then put the energy back

300 00:15:48.880 --> 00:15:50.610 into the atmosphere above the boundary layer.

301 00:15:50.610 --> 00:15:53.320 So that's one energy redistribution process.

302 00:15:53.320 --> 00:15:57.440 A second energy redistribution process is connection,

303 00:15:57.440 --> 00:16:01.570 is really is due, is the result of an emotion result

304 00:16:01.570 --> 00:16:03.670 of triplet motion in the boundary layer.

305 00:16:03.670 --> 00:16:08.670 That process is dissipating energy from the ground

306 00:16:11.240 --> 00:16:13.433 to the lower atmosphere.

307 00:16:15.141 --> 00:16:18.300 So you can set up this kind of thought experiment

308 00:16:18.300 --> 00:16:23.300 to look at how the two, the processes play out, right?

309 00:16:24.210 --> 00:16:25.930 In this thought experiment

310 00:16:25.930 --> 00:16:30.590 Or you can also do this in numerical, in the motto as well.

311 00:16:30.590 --> 00:16:35.590 You put a forest next to an open land

312 00:16:35.930 --> 00:16:40.150 and the two patches of landscape are influenced

313 00:16:40.150 --> 00:16:43.830 by same atmospheric conditions in terms of temperature,

314 00:16:43.830 --> 00:16:45.260 background temperature,

315 00:16:45.260 --> 00:16:49.290 in terms of incoming solar radiation, long wave radiation

316 00:16:49.290 --> 00:16:51.150 and so basically the value

317 00:16:51.150 --> 00:16:53.360 that those quantities are the same

318 00:16:53.360 --> 00:16:55.230 across the two patches of land

319 00:16:55.230 --> 00:16:57.740 at this order called a Blending height

320 00:16:57.740 --> 00:16:59.900 which is typically taking its first mode

321 00:16:59.900 --> 00:17:02.024 of great height about 50 meters

322 00:17:02.024 --> 00:17:04.460 to a 100 meters above the surface right?

323 00:17:04.460 --> 00:17:08.670 And then, so in this kind of site pair analysis

324 00:17:08.670 --> 00:17:13.670 all a space for a time analysis that the contrast open land

325 00:17:14.350 --> 00:17:17.060 the contrast in temperature which an open land

326 00:17:17.060 --> 00:17:18.640 and the forest land is really your,

327 00:17:18.640 --> 00:17:21.040 is really the deforestation signal

328 00:17:21.040 --> 00:17:26.040 cause that's how we approach this particular problem, right?

329 00:17:26.920 --> 00:17:28.700 And so I don't want to get into too much

330 00:17:28.700 --> 00:17:31.610 of a mathematical details except to say,

331 00:17:31.610 --> 00:17:36.210 this is how we frame the problem,

332 00:17:36.210 --> 00:17:37.367 we combined what we call

333 00:17:37.367 --> 00:17:41.453 the one source of a model for heat transfer,

334 00:17:42.840 --> 00:17:47.040 surface energy balance conservation of energy at the surface

335 00:17:47.040 --> 00:17:50.060 to formulate our solution for surface temperature

336 00:17:50.060 --> 00:17:54.030 so in this One source Model heat is dissipated

337 00:17:54.030 --> 00:17:57.710 from the ground to Reference height

338 00:17:57.710 --> 00:18:00.550 and using some kind of resistance analog right?

339 00:18:00.550 --> 00:18:03.900 So the heat of efficiency of heat flux

340 00:18:03.900 --> 00:18:06.360 is really proportional to temperature difference

341 00:18:06.360 --> 00:18:07.343 between difference in temperature

342 00:18:07.343 --> 00:18:10.600 between the surface and temperature at a lower atmosphere

343 00:18:10.600 --> 00:18:12.440 at a per landing height.

344 00:18:12.440 --> 00:18:16.480 So you combine those two sort of considerations.

345 00:18:16.480 --> 00:18:19.970 You'll come up with a solution for surface temperature

346 00:18:21.270 --> 00:18:25.080 And then you do a sort of the perturbation to decide

347 00:18:25.080 --> 00:18:26.340 mathematically it's just,

348 00:18:26.340 --> 00:18:31.000 that's equivalent to differentiating this equation

349 00:18:31.000 --> 00:18:34.110 and so you then get perturbation signal.

350 00:18:34.110 --> 00:18:36.830 That's your temp deforestation signal

351 00:18:36.830 --> 00:18:38.203 by replacing it four of this open land,

352 00:18:38.203 --> 00:18:39.720 you get a temperature change,

353 00:18:39.720 --> 00:18:41.630 that's the temperature change mathematically

354 00:18:41.630 --> 00:18:42.970 and then the temperature changes

355 00:18:42.970 --> 00:18:45.367 then it's partitioned into three components.

356 00:18:45.367 --> 00:18:48.803 The first component has to do with changing albedo.

357 00:18:50.002 --> 00:18:52.580 I mentioned earlier using that Israel example,

358 00:18:52.580 --> 00:18:54.160 the second component has to do is back.

359 00:18:54.160 --> 00:18:57.020 The energy redistribution efficiency has changed

360 00:18:58.418 --> 00:18:59.930 due to a change of reference.

361 00:18:59.930 --> 00:19:04.650 So forest landscape is very rough and very efficient

362 00:19:04.650 --> 00:19:05.880 in generating triplets,

363 00:19:05.880 --> 00:19:09.400 It's very efficient in dissipating energy by triplets

364 00:19:09.400 --> 00:19:12.600 but open land, it's very smooth so it's not as efficient.

365 00:19:12.600 --> 00:19:16.950 So that itself will cause change in temperature

366 00:19:16.950 --> 00:19:20.310 and then the third component contribution

367 00:19:20.310 --> 00:19:22.700 is change of energy redistribution

368 00:19:22.700 --> 00:19:26.027 due to evaporation change or change of evaporation

369 00:19:26.027 --> 00:19:27.920 and that can go either way

370 00:19:27.920 --> 00:19:29.760 when you compare forest to open land

371 00:19:29.760 --> 00:19:32.900 depending a forest cover to open land

372 00:19:32.900 --> 00:19:36.870 depending on which one has higher evaporation potential.

373 00:19:36.870 --> 00:19:41.590 So that is the approach we use to study a deforestation

374 00:19:41.590 --> 00:19:45.650 and it later turns out that we have two prompters here,

375 00:19:45.650 --> 00:19:50.110 one is this local climate sensitivity prompter

376 00:19:50.110 --> 00:19:52.290 which is more or less constant

377 00:19:52.290 --> 00:19:55.320 but this prompt F is energy redistribution factor.

378 00:19:55.320 --> 00:19:56.890 Some people have done quite a bit of work

379 00:19:56.890 --> 00:19:59.193 on this prompter and turns out this prompers

380 00:19:59.193 --> 00:20:03.340 more like a property of the landscape.

381 00:20:03.340 --> 00:20:06.760 So for example, this is a study by Bright et al

382 00:20:06.760 --> 00:20:09.110 looking at Energy redistribution factor

383 00:20:09.110 --> 00:20:11.113 for different ecosystem.

384 00:20:12.520 --> 00:20:14.703 This is evergreen needle-leaf forest,

385 00:20:15.801 --> 00:20:18.400 deciduous broad-leaf forest

386 00:20:18.400 --> 00:20:20.230 evergreen broad-leaf forest

387 00:20:20.230 --> 00:20:24.677 and this is a two types of crop lands, rain fat irrigated

388 00:20:24.677 --> 00:20:26.250 and this is grassland.

389 00:20:26.250 --> 00:20:29.300 Typically when you compare a forest

390 00:20:29.300 --> 00:20:31.440 versus the grass open land,

391 00:20:31.440 --> 00:20:33.400 you find the energy redistribution factor

392 00:20:33.400 --> 00:20:34.520 much high for forest

393 00:20:34.520 --> 00:20:38.690 especially for tropical evergreen broad-leaf forest

394 00:20:38.690 --> 00:20:43.003 meaning that they are a disturbance,

395 00:20:44.415 --> 00:20:46.700 just external sort of perturbation

396 00:20:46.700 --> 00:20:47.920 will not change his temperature

397 00:20:47.920 --> 00:20:52.590 as much same perturbation occurring over grassland

398 00:20:52.590 --> 00:20:56.480 because over or at this kind of landscape,

399 00:20:56.480 --> 00:20:58.970 the energy is can be dissipated very quickly

400 00:20:58.970 --> 00:20:59.921 to the atmosphere

401 00:20:59.921 --> 00:21:03.543 and therefore is more resistant to change in temperature,

402 00:21:05.020 --> 00:21:10.020 and then later on TC from my lab did this calculation

403 00:21:11.070 --> 00:21:15.970 mapping the energy redistribution factor across the globe

404 00:21:15.970 --> 00:21:18.980 given the current distribution of vegetation types

405 00:21:18.980 --> 00:21:23.900 of course and you find a high value in tropical places

406 00:21:23.900 --> 00:21:24.850 and low Value elsewhere

407 00:21:24.850 --> 00:21:27.210 and then Nighttime value is much lower

408 00:21:28.265 --> 00:21:30.450 so there's, when you look at tables

409 00:21:30.450 --> 00:21:33.420 night contrast Daytime energy redistribution factors

410 00:21:33.420 --> 00:21:36.080 is much higher than at Nighttime

411 00:21:36.080 --> 00:21:39.090 meaning that same amount of changes

412 00:21:39.090 --> 00:21:42.790 of a disturbance would cause much higher response

413 00:21:42.790 --> 00:21:45.850 in temperature at nighttime than in the daytime.

414 00:21:45.850 --> 00:21:47.550 So that kind of day and night symmetry

415 00:21:47.550 --> 00:21:49.990 is also very important in the consideration

416 00:21:49.990 --> 00:21:54.053 of how land use change affects the surface temperature.

417 00:21:55.270 --> 00:21:57.258 So basically then we'd say okay well,

418 00:21:57.258 --> 00:21:59.740 let's just extend this to urban landscape right?

419 00:21:59.740 --> 00:22:02.420 You've sent the urban landscape now

420 00:22:02.420 --> 00:22:04.850 instead of contrasting for us was open ended.

421 00:22:04.850 --> 00:22:08.120 We are contrasting a natural land versus urban land.

422 00:22:08.120 --> 00:22:10.610 That's the urban heat Island signal right?

423 00:22:10.610 --> 00:22:14.300 And so you go through that little model you find

424 00:22:14.300 --> 00:22:17.860 then now you have five contributions

425 00:22:17.860 --> 00:22:19.100 five factors contributing.

426 00:22:19.100 --> 00:22:22.350 One is changing the albedo or radiation convection effect,

427 00:22:22.350 --> 00:22:24.730 evaporation effect changing storage

428 00:22:24.730 --> 00:22:26.480 and change your anthropogenic heat.

429 00:22:27.330 --> 00:22:31.160 So a few years ago, my former student lays out,

430 00:22:31.160 --> 00:22:33.460 did this attribution analysis based on

431 00:22:35.954 --> 00:22:38.540 this model and then did a partitioning

432 00:22:38.540 --> 00:22:40.550 of urban heat island intensity

433 00:22:40.550 --> 00:22:42.190 to and partition the urban heat Island

434 00:22:42.190 --> 00:22:43.830 intensinty to different factors

435 00:22:43.830 --> 00:22:47.710 and this is a very complex plot that maybe I should show you

436 00:22:47.710 --> 00:22:50.370 I tend to just read this particular diagram.

437 00:22:50.370 --> 00:22:51.780 This diagram is daytime

438 00:22:51.780 --> 00:22:56.501 urban heat island on in situation for four cities in East,

439 00:22:56.501 --> 00:23:00.430 Southeast United States including where we are

440 00:23:00.430 --> 00:23:02.593 and so this is sort of wet climate.

441 00:23:03.430 --> 00:23:07.550 So and this is the modis settling observed over here.

442 00:23:07.550 --> 00:23:08.720 He did in intensity,

443 00:23:08.720 --> 00:23:11.520 this a climate model calculate intensity.

444 00:23:11.520 --> 00:23:16.040 This is the summation of the in individual terms,

445 00:23:16.040 --> 00:23:17.970 individual contributions right?

446 00:23:17.970 --> 00:23:22.970 So in the case of cities, this part of the world actually

447 00:23:24.530 --> 00:23:27.240 Albedo effect is cooling

448 00:23:27.240 --> 00:23:30.580 so contrary to what many people believe

449 00:23:30.580 --> 00:23:35.060 turns out cities in this part of the country

450 00:23:35.060 --> 00:23:39.440 our axe is brighter than the background,

451 00:23:39.440 --> 00:23:40.960 but then the rural background

452 00:23:40.960 --> 00:23:43.260 is mostly forests are dark

453 00:23:43.260 --> 00:23:45.550 so the Albedo effect is cooling

454 00:23:45.550 --> 00:23:47.110 but so what's surprised us actually,

455 00:23:47.110 --> 00:23:49.320 is this connection effect right?

456 00:23:49.320 --> 00:23:50.153 It turns out

457 00:23:53.051 --> 00:23:53.973 in this this kind of climate,

458 00:23:55.789 --> 00:24:00.410 this region urban land is not efficient in dissipating heat

459 00:24:00.410 --> 00:24:02.650 than the background forest land

460 00:24:02.650 --> 00:24:07.290 and so as a result of loss of convection efficiency

461 00:24:07.290 --> 00:24:09.770 you have an obviously a lot of warming.

462 00:24:09.770 --> 00:24:11.840 So it's actually this loss efficiency

463 00:24:11.840 --> 00:24:14.363 dominates urban heat Island intensity,

464 00:24:15.660 --> 00:24:18.443 is much stronger than the effect

465 00:24:19.452 --> 00:24:22.102 of loss of evaporative cooling, right?

466 00:24:22.102 --> 00:24:25.170 So that's the that kind of interpretation

467 00:24:27.156 --> 00:24:29.970 of the based on that model

468 00:24:29.970 --> 00:24:32.280 and so this kind of attribution.

469 00:24:32.280 --> 00:24:34.420 this kind of practitioner is obviously very important

470 00:24:34.420 --> 00:24:38.240 when you've tried to formulate a mitigation strategy

471 00:24:38.240 --> 00:24:39.970 whether you want to say for example,

472 00:24:39.970 --> 00:24:42.080 you want to change our Albedo or change

473 00:24:44.180 --> 00:24:45.380 in evaporating

474 00:24:47.700 --> 00:24:50.550 client trees by improving evaporation.

475 00:24:50.550 --> 00:24:52.750 So you can use this to help determine

476 00:24:52.750 --> 00:24:54.350 which one is more efficient

477 00:24:54.350 --> 00:24:58.650 whether Albedo of change or change of gray infrastructure

478 00:24:58.650 --> 00:25:00.620 or tangible green infrastructure

479 00:25:00.620 --> 00:25:02.653 which one gives you more cooling power.

480 00:25:04.540 --> 00:25:07.730 And then so that study was done prior

481 00:25:09.564 --> 00:25:10.397 to Google earth engine

482 00:25:10.397 --> 00:25:15.003 not always before Google earth engine error.

483 00:25:17.339 --> 00:25:20.600 So we've hand picked a 60 some cities

484 00:25:20.600 --> 00:25:23.530 and we manually select a satellite data

485 00:25:23.530 --> 00:25:26.200 and that was a lot of work right?

486 00:25:26.200 --> 00:25:28.290 But now we Google Earth Engine

487 00:25:28.290 --> 00:25:32.290 the marking of Urban heat island much easier.

488 00:25:32.290 --> 00:25:33.800 I just want to draw your attention

489 00:25:33.800 --> 00:25:36.160 to the work done by TC again,

490 00:25:36.160 --> 00:25:39.110 he used the Google App Engine

491 00:25:39.110 --> 00:25:41.837 to map out basically the urban heat island

492 00:25:41.837 --> 00:25:44.253 for all the cities in the world.

493 00:25:45.252 --> 00:25:48.780 You can go to this link and you can pick any city.

494 00:25:48.780 --> 00:25:53.400 I can then, there's this interface allows you,

495 00:25:53.400 --> 00:25:58.400 this Explorer allows you to map out local urban heat Island

496 00:25:59.150 --> 00:26:03.190 and also variation of time change of urban heat island

497 00:26:03.190 --> 00:26:04.240 or the satellite air.

498 00:26:06.544 --> 00:26:09.100 Now let me switch gear here

499 00:26:09.100 --> 00:26:12.050 and speak about mitigation right?

500 00:26:12.050 --> 00:26:15.209 Mitigation and we know urban heat Island

501 00:26:15.209 --> 00:26:18.390 is not a a good thing, especially in hot weather conditions,

502 00:26:18.390 --> 00:26:22.840 it exacerbate the heat stress on our urban residents

503 00:26:22.840 --> 00:26:26.640 so we like to perhaps modified urban landscape

504 00:26:26.640 --> 00:26:29.020 to comeback, to control,

505 00:26:29.020 --> 00:26:32.583 to reduce the intensity of Urban heat island.

506 00:26:37.172 --> 00:26:39.960 So this is a sort of a summary

507 00:26:39.960 --> 00:26:42.940 of the kind of strategies that people are considering right?

508 00:26:42.940 --> 00:26:44.970 One strategy is white roof,

509 00:26:44.970 --> 00:26:49.320 you basically convert a dark roof to replace dark roof

510 00:26:49.320 --> 00:26:53.210 with some kind of a white shiny bright material

511 00:26:53.210 --> 00:26:58.210 to increase Albedo so you then cool the urban climate.

512 00:26:58.790 --> 00:27:00.376 The other strategy

513 00:27:00.376 --> 00:27:05.210 is strategy promoted by the city of Chicago you know,

514 00:27:05.210 --> 00:27:08.080 putting green vegetation on rooftop

515 00:27:08.080 --> 00:27:10.960 like indicate this case is a City Hall

516 00:27:12.806 --> 00:27:14.080 and a third strategy is the one

517 00:27:14.080 --> 00:27:18.470 that our school used is to convert a rooftop

518 00:27:18.470 --> 00:27:21.650 to Solar Panel to cover the rooftop with Solar Panel.

519 00:27:21.650 --> 00:27:23.890 The benefit there is that instead

520 00:27:23.890 --> 00:27:26.740 of allowing radiation

521 00:27:26.740 --> 00:27:28.660 to turn into heat,

522 00:27:28.660 --> 00:27:31.230 you actually capture solar radiation

523 00:27:31.230 --> 00:27:33.750 and convert some of it into electricity

524 00:27:34.780 --> 00:27:38.610 and therefore avoiding heating the local environment right?

525 00:27:38.610 --> 00:27:41.000 So that would also bring cooling benefits.

526 00:27:41.000 --> 00:27:44.280 It's a fourth approach is to use

527 00:27:44.280 --> 00:27:46.780 Street trees

528 00:27:46.780 --> 00:27:47.740 to help cool

529 00:27:48.930 --> 00:27:50.240 whenever you can

530 00:27:50.240 --> 00:27:53.403 wherever you can plant trees to cooll the local climate.

531 00:27:54.830 --> 00:27:57.983 So the question is which one is more effective, right?

532 00:28:00.396 --> 00:28:04.140 And if so how do you quantify that

533 00:28:04.140 --> 00:28:06.710 before I do give you a solid quantification,

534 00:28:06.710 --> 00:28:11.600 I just want to draw your attention to this case in Chicago.

535 00:28:11.600 --> 00:28:14.310 It turns out changing roof top albedo

536 00:28:14.310 --> 00:28:16.500 is not a theoretical concept,

537 00:28:16.500 --> 00:28:19.960 it's actually been actively promoted in many cities,

538 00:28:19.960 --> 00:28:22.730 city of Chicago was one of the pioneer cities

539 00:28:22.730 --> 00:28:25.640 promoting this idea, promoting this approach

540 00:28:25.640 --> 00:28:29.120 using a brighter reflective materials

541 00:28:29.120 --> 00:28:30.940 to help cool the local climate

542 00:28:30.940 --> 00:28:32.110 to help control

543 00:28:33.600 --> 00:28:35.893 the local urban heat Island,

544 00:28:35.893 --> 00:28:38.360 this is a work done by a former student

545 00:28:40.558 --> 00:28:43.640 of professor Ron Smith and myself.

546 00:28:43.640 --> 00:28:47.390 So he quantified change in urban out Albedo

547 00:28:48.420 --> 00:28:52.100 in Chicago after 1995, after that notorious heat wave

548 00:28:52.100 --> 00:28:54.470 that kills a hundreds of people

549 00:28:54.470 --> 00:28:56.400 and turns out we can actually,

550 00:28:56.400 --> 00:29:00.730 we were able to quantify change of the citywide Albedo

551 00:29:00.730 --> 00:29:02.670 the city over this time period,

552 00:29:02.670 --> 00:29:06.963 the city Albedo has increased by a little bit by 0.02,

553 00:29:08.750 --> 00:29:11.920 but, so you can actually quantify,

554 00:29:11.920 --> 00:29:13.560 this is a homework exercise.

555 00:29:13.560 --> 00:29:16.930 I'll ask my students to do when they do my class

556 00:29:16.930 --> 00:29:20.630 and this isn't in my book, sort of homework exercise

557 00:29:20.630 --> 00:29:23.060 you know the question ask,

558 00:29:23.060 --> 00:29:25.860 the question we're asking students to do is that,

559 00:29:25.860 --> 00:29:27.210 when the albedo,

560 00:29:27.210 --> 00:29:30.050 if Albedo is increased by this much estimate

561 00:29:30.050 --> 00:29:33.420 how much temperature reduction you get, right?

562 00:29:33.420 --> 00:29:36.180 So you can basically go back to that model

563 00:29:36.180 --> 00:29:38.600 that I presented you earlier

564 00:29:38.600 --> 00:29:40.670 but now the situation is much simpler,

565 00:29:40.670 --> 00:29:42.360 you don't need to worry

566 00:29:42.360 --> 00:29:44.290 about changing energy REdistribution

567 00:29:44.290 --> 00:29:46.350 because we have not changed urban form.

568 00:29:46.350 --> 00:29:47.410 We all only did,

569 00:29:47.410 --> 00:29:51.270 only what we did was just to change the roof of Albedo.

570 00:29:51.270 --> 00:29:54.060 So you have that single prompter problem

571 00:29:54.060 --> 00:29:55.890 and if you put numbers together,

572 00:29:55.890 --> 00:30:00.200 you'll find that the 0.02 Change increase in Albedo

573 00:30:00.200 --> 00:30:04.610 would cause a cooling on average of 1.5 degrees Celsius.

574 00:30:04.610 --> 00:30:08.420 That could be quite important in the event of a heat wave.

575 00:30:10.862 --> 00:30:14.790 Now let me share with you the pertinent results, right?

576 00:30:14.790 --> 00:30:17.710 So we, that in the case of Chicago,

577 00:30:17.710 --> 00:30:19.600 that's, what's really a local example

578 00:30:19.600 --> 00:30:24.270 and then we with lays work, we use climate models

579 00:30:24.270 --> 00:30:27.010 and in with fall, all kinds of scenarios

580 00:30:27.010 --> 00:30:29.230 considerations, climate consideration,

581 00:30:29.230 --> 00:30:32.000 climate scenarios also mitigation scenarios

582 00:30:32.000 --> 00:30:34.690 using our partition efforts.

583 00:30:34.690 --> 00:30:35.523 So this is a...

584 00:30:35.523 --> 00:30:37.493 Let me help you interpret this diagram a little bit.

585 00:30:37.493 --> 00:30:42.493 This is the condition for Mid summer day

586 00:30:42.790 --> 00:30:45.660 for cities in the United States average condition

587 00:30:45.660 --> 00:30:47.690 of all the cities in the United States

588 00:30:47.690 --> 00:30:50.140 not also the 60 some cities in the United States.

589 00:30:50.980 --> 00:30:54.050 So this is, would be the current background temperature.

590 00:30:54.050 --> 00:30:54.883 You get

591 00:30:56.433 --> 00:30:57.300 on a hot summer,

592 00:30:57.300 --> 00:31:01.570 at summer noontime in rural background,

593 00:31:01.570 --> 00:31:02.403 okay?

594 00:31:02.403 --> 00:31:05.020 And this is then the urban temperatures here

595 00:31:05.020 --> 00:31:06.620 on the current climate condition

596 00:31:06.620 --> 00:31:09.760 in a future climate near the end of century,

597 00:31:09.760 --> 00:31:12.430 the rural background will be up here

598 00:31:12.430 --> 00:31:14.240 and urban temperature would be up here.

599 00:31:14.240 --> 00:31:15.810 So we will forever residents,

600 00:31:15.810 --> 00:31:20.390 we were gonna expect this much of a temperature, right?

601 00:31:20.390 --> 00:31:23.540 We referenced to current rural background

602 00:31:23.540 --> 00:31:27.460 and so by implementing core roofs

603 00:31:27.460 --> 00:31:28.780 we are, we stay in the model,

604 00:31:28.780 --> 00:31:33.780 we change all the roofs to core to highly reflective roofs.

605 00:31:34.110 --> 00:31:35.810 We get this much of cooling,

606 00:31:35.810 --> 00:31:38.200 that's substacalling substantial right?

607 00:31:38.200 --> 00:31:42.770 Basically you raise all the urban heat Island effect

608 00:31:42.770 --> 00:31:45.650 and all some greenhouse effect

609 00:31:45.650 --> 00:31:48.420 and then we say, okay, let's plant street trees,

610 00:31:48.420 --> 00:31:51.570 well, there's only a limited space

611 00:31:51.570 --> 00:31:52.870 for planting street trees,

612 00:31:52.870 --> 00:31:57.870 but we planted street trees in the model anywhere we can

613 00:31:58.090 --> 00:32:00.720 and also we change reflect your pavements

614 00:32:00.720 --> 00:32:04.340 change your pavements to reflect your material.

615 00:32:04.340 --> 00:32:06.640 So this is what we call additive effects,

616 00:32:06.640 --> 00:32:11.640 it's like the IBL from mitigation wedge, right?

617 00:32:11.750 --> 00:32:13.510 People talk about when we talk about dealing

618 00:32:13.510 --> 00:32:15.390 with greenhouse mitigation here,

619 00:32:15.390 --> 00:32:18.030 you can use the same idea of a wedge idea

620 00:32:18.030 --> 00:32:21.510 to see the attitude of strategies

621 00:32:22.997 --> 00:32:25.890 for mitigating urban heat Island.

622 00:32:25.890 --> 00:32:30.400 So in this is very aggressive scenario of course

623 00:32:30.400 --> 00:32:34.720 we can raise all the Urban heat island

624 00:32:34.720 --> 00:32:36.450 and greenhouse effect.

625 00:32:36.450 --> 00:32:39.280 We actually have some additional cooling

626 00:32:39.280 --> 00:32:41.780 of course, it's highly idealized and real world,

627 00:32:41.780 --> 00:32:44.790 we cannot achieve this maximum cooling

628 00:32:45.870 --> 00:32:48.230 but it's instructive to show that indeed

629 00:32:48.230 --> 00:32:52.570 a core roof Australia is much more effective

630 00:32:52.570 --> 00:32:56.353 than street tree or reflect your payment.

631 00:32:58.820 --> 00:33:01.570 So spatially, this is what this looks lik, right?

632 00:33:01.570 --> 00:33:02.690 If you don't do

633 00:33:05.627 --> 00:33:08.500 any change to the urban landscape at the end of the century

634 00:33:08.500 --> 00:33:11.083 you will still have a lot of urban heat Island.

635 00:33:11.083 --> 00:33:12.823 This is circle,

636 00:33:14.090 --> 00:33:15.020 warm color circles

637 00:33:15.020 --> 00:33:16.630 indicate Urban heat island.

638 00:33:16.630 --> 00:33:20.930 We have a few cities that actually have cool like Island

639 00:33:21.990 --> 00:33:24.943 indicated by the cold color,

640 00:33:26.120 --> 00:33:28.150 but they never that's on average,

641 00:33:28.150 --> 00:33:31.100 you've got quite strong urban heat Island

642 00:33:31.100 --> 00:33:35.170 but if you use EPA white roof everywhere in this cities,

643 00:33:35.170 --> 00:33:38.450 you actually now have a cold Island almost

644 00:33:38.450 --> 00:33:41.003 across the whole country.

645 00:33:42.090 --> 00:33:44.260 This is of course in a Daytime situation

646 00:33:44.260 --> 00:33:46.070 but the white roof does not work as well

647 00:33:46.070 --> 00:33:47.440 for nighttime obviously, right?

648 00:33:47.440 --> 00:33:51.700 White roof works because it reflects sunlight in the daytime

649 00:33:51.700 --> 00:33:54.420 but at nighttime there's no sunlight took to stick off

650 00:33:54.420 --> 00:33:58.520 so you don't get much of a benefit at nighttime.

651 00:33:58.520 --> 00:34:01.720 So that still would be still is an important

652 00:34:01.720 --> 00:34:06.173 hurdle to overcome how do you call a nighttime temperature?

653 00:34:08.300 --> 00:34:11.763 The white roof would not be an effective approach for that.

654 00:34:18.255 --> 00:34:22.480 So that the calculation is done really theoretical right,

655 00:34:22.480 --> 00:34:24.416 in the theoretical calculation

656 00:34:24.416 --> 00:34:26.910 and we don't really get a sense

657 00:34:26.910 --> 00:34:29.460 of the kind of change we are calling for,

658 00:34:29.460 --> 00:34:32.720 the change Urban land form is really substantial.

659 00:34:32.720 --> 00:34:34.860 If you really want to follow this strategy

660 00:34:36.114 --> 00:34:39.000 I'll be implementing white roof everywhere.

661 00:34:39.000 --> 00:34:40.060 So for that

662 00:34:41.610 --> 00:34:43.350 we decided to well the triplets,

663 00:34:43.350 --> 00:34:44.760 do some visualization.

664 00:34:44.760 --> 00:34:46.570 This visualization is based on

665 00:34:47.840 --> 00:34:50.560 sense fly a data source

666 00:34:50.560 --> 00:34:54.910 sort of drawn data collected by this company

667 00:34:54.910 --> 00:34:58.760 over a neighborhood in a city in,

668 00:34:58.760 --> 00:35:01.220 I think in Switzerland

669 00:35:02.700 --> 00:35:06.080 and so we then use this to it to some animation.

670 00:35:06.080 --> 00:35:08.353 Let me see if can turn the animation over here.

671 00:35:11.651 --> 00:35:12.801 It does not, let me see

672 00:35:17.380 --> 00:35:19.153 way by control here.

673 00:35:29.028 --> 00:35:30.410 (indistinct) Okay there it's go

674 00:35:33.076 --> 00:35:35.220 So this is the current landscape, right?

675 00:35:35.220 --> 00:35:38.350 We're doing a fly by as if we were a bird

676 00:35:38.350 --> 00:35:41.040 looking at the landscape from different angles.

677 00:35:41.040 --> 00:35:42.643 It's a very pleasant landscape,

678 00:35:43.729 --> 00:35:45.800 you know, have a dark roof

679 00:35:45.800 --> 00:35:48.860 green lawn and street trees

680 00:35:59.830 --> 00:36:01.060 and then we say, okay well,

681 00:36:01.060 --> 00:36:03.490 we'd like to change this landscape

682 00:36:03.490 --> 00:36:05.140 because we are we are very concerned

683 00:36:05.140 --> 00:36:06.510 about urban heat Island.

684 00:36:06.510 --> 00:36:07.580 So we then,

685 00:36:07.580 --> 00:36:12.030 we can artificially digitally alter the roof material

686 00:36:12.030 --> 00:36:16.230 to a white shiny high albedo material

687 00:36:16.230 --> 00:36:18.833 and then we'd do a fly by, right?

688 00:36:41.010 --> 00:36:42.540 So that, this is kind of landscape

689 00:36:42.540 --> 00:36:44.519 we are, we'll be looking at

690 00:36:44.519 --> 00:36:48.520 if we do implement that white roof strategy

691 00:36:48.520 --> 00:36:51.760 and of course, it's this very alien landscape,

692 00:36:51.760 --> 00:36:52.750 we are not very used to,

693 00:36:52.750 --> 00:36:55.090 a lot of people criticize us for saying that

694 00:36:55.090 --> 00:36:57.250 because they said, this is not a pleasant landscape

695 00:36:57.250 --> 00:36:59.340 to a city to be in

696 00:37:00.470 --> 00:37:02.740 and pass maybe you wouldn't be detrimental

697 00:37:04.790 --> 00:37:08.540 to pilots because they can't see the ground well

698 00:37:08.540 --> 00:37:09.890 and maybe they will get blinded

699 00:37:09.890 --> 00:37:11.860 by the Brighton yourself

700 00:37:14.841 --> 00:37:16.070 the roof.

701 00:37:16.070 --> 00:37:20.920 But anyway, so that's obviously a big change we need,

702 00:37:20.920 --> 00:37:23.270 we will be expecting

703 00:37:23.270 --> 00:37:25.220 but now let me switch gear a little bit

704 00:37:26.533 --> 00:37:28.040 to what we are doing now.

705 00:37:28.040 --> 00:37:30.040 So I won't pick a criticism

706 00:37:30.040 --> 00:37:32.630 of the work we have been doing is that

707 00:37:32.630 --> 00:37:34.260 we are using surface temperature

708 00:37:34.260 --> 00:37:36.800 as a measure of heat stress,

709 00:37:36.800 --> 00:37:38.980 temperature at the surface of landscape

710 00:37:38.980 --> 00:37:43.980 but people obviously, this is obviously is not accurate

711 00:37:44.050 --> 00:37:46.600 because to measure heat stress,

712 00:37:46.600 --> 00:37:48.760 you need to use air temperature

713 00:37:48.760 --> 00:37:52.470 and furthermore heat stress is not only caused

714 00:37:52.470 --> 00:37:56.270 by temperature, it's also caused by high humidity.

715 00:37:56.270 --> 00:37:58.060 So strictly you should,

716 00:37:58.060 --> 00:38:01.010 we should be using some kind of combined index,

717 00:38:01.010 --> 00:38:03.350 index that can combine both air temperature,

718 00:38:03.350 --> 00:38:05.510 not surface temperature but air temperature

719 00:38:05.510 --> 00:38:06.560 and also air humidity

720 00:38:08.670 --> 00:38:12.030 so that a perspective from the thermodynamic person,

721 00:38:12.030 --> 00:38:15.110 turns out the best way of measuring the combined effect

722 00:38:15.110 --> 00:38:17.213 is to use one called Wet-bulb temperature,

723 00:38:18.258 --> 00:38:19.280 in meteorology,

724 00:38:19.280 --> 00:38:21.640 this is how we measure Wet-bulb temperature, right?

725 00:38:21.640 --> 00:38:25.350 So we cover the thermometer with some kind of Wet cloth

726 00:38:25.350 --> 00:38:27.440 allowing the surface of the thermometer

727 00:38:27.440 --> 00:38:29.050 to be wet all the time

728 00:38:29.050 --> 00:38:33.709 and so, and allow the evaporation to occur at the surface

729 00:38:33.709 --> 00:38:35.733 and so the temperature you imagine

730 00:38:35.733 --> 00:38:38.950 that this situation is Wet-bulb temperature

731 00:38:40.180 --> 00:38:42.430 and so that's a thermodynamic parameter

732 00:38:42.430 --> 00:38:44.937 that meteorologists use a lot

733 00:38:44.937 --> 00:38:48.120 to characterize the thermal environment.

734 00:38:48.120 --> 00:38:52.170 It turns out though in a hot environment

735 00:38:52.170 --> 00:38:56.240 sweating is obviously is a way, it's the only way actually

736 00:38:56.240 --> 00:38:58.913 for us to maintain low skin temperature,

737 00:39:00.354 --> 00:39:02.590 a person who is sweating a lot

738 00:39:02.590 --> 00:39:05.880 can be considered essentially a big wet bulb

739 00:39:07.642 --> 00:39:11.234 cause we assume the body is exposed,

740 00:39:11.234 --> 00:39:15.600 no clothing and the whole body is covered with sweat

741 00:39:16.490 --> 00:39:18.253 so analogous to a wet bulb.

742 00:39:20.419 --> 00:39:25.419 So then you can use wet bulb temperature to see the effect

743 00:39:26.423 --> 00:39:28.800 of heat stress on human body

744 00:39:28.800 --> 00:39:30.810 and as I said earlier

745 00:39:31.893 --> 00:39:33.240 to stay alive

746 00:39:33.240 --> 00:39:35.910 just to survive hard environment

747 00:39:35.910 --> 00:39:38.460 we need to maintain a two degree difference

748 00:39:38.460 --> 00:39:41.940 between skin and a deep body temperature

749 00:39:41.940 --> 00:39:44.700 so that our body can dissipate heat

750 00:39:44.700 --> 00:39:46.210 to the environment right?

751 00:39:46.210 --> 00:39:48.580 But then it turns out if the We-bulb temperature

752 00:39:48.580 --> 00:39:51.250 of the environment goes beyond 35 degrees,

753 00:39:51.250 --> 00:39:52.940 this is no longer possible,

754 00:39:52.940 --> 00:39:55.686 we cannot, we wouldn't be able to be able

755 00:39:55.686 --> 00:39:57.900 to maintain a two degree difference.

756 00:39:57.900 --> 00:40:01.810 Our skin temperature would be higher than 35 degrees

757 00:40:01.810 --> 00:40:05.890 and if we don't have air conditioning.

758 00:40:05.890 --> 00:40:08.730 So without air conditioning we cannot survive

759 00:40:08.730 --> 00:40:11.640 when external environmental temperature

760 00:40:11.640 --> 00:40:14.960 or Wet-bulb temperature goes beyond 35 degrees.

761 00:40:14.960 --> 00:40:19.030 That's really the physiological barrier

762 00:40:19.030 --> 00:40:23.290 the limit that you know, determines the survivability

763 00:40:23.290 --> 00:40:27.180 or habitability of the law of the environment.

764 00:40:27.180 --> 00:40:32.180 So we are knowledge high trying to come up with a strategy

765 00:40:33.322 --> 00:40:35.740 of studying using a wet bulb

766 00:40:35.740 --> 00:40:38.340 instead of the surface temperature to quantity

767 00:40:38.340 --> 00:40:40.060 that's undergoing a new project,

768 00:40:40.060 --> 00:40:44.780 it's a collaborative project happening here at Yale,

769 00:40:44.780 --> 00:40:47.860 it's called Biking for Science and Health

770 00:40:47.860 --> 00:40:50.190 and so the idea is that we can use bicycles

771 00:40:50.190 --> 00:40:54.280 to help out map out temperature and humidity

772 00:40:54.280 --> 00:40:56.180 across urban and rural landscape

773 00:40:56.180 --> 00:40:58.890 and use that as a way of collecting data

774 00:40:58.890 --> 00:41:01.950 to validate a model calculation

775 00:41:01.950 --> 00:41:02.783 of course

776 00:41:03.988 --> 00:41:06.930 the project oe the objective of this project

777 00:41:06.930 --> 00:41:11.750 is much broader than only measuring temperature.

778 00:41:11.750 --> 00:41:13.240 So the broad objective

779 00:41:13.240 --> 00:41:15.870 is to integrate smart sensor technology

780 00:41:15.870 --> 00:41:17.340 with public bicycles

781 00:41:17.340 --> 00:41:19.440 or maybe private bicycles as well

782 00:41:19.440 --> 00:41:21.220 for urban environmental monitoring

783 00:41:22.350 --> 00:41:24.220 so T-Mobile for scientists

784 00:41:24.220 --> 00:41:28.700 including professor Dubrow as part of the team

785 00:41:28.700 --> 00:41:31.820 and so this is that the idea right?

786 00:41:31.820 --> 00:41:34.320 So we, what we want to do is to convert bicycles

787 00:41:34.320 --> 00:41:38.710 into measurement platform either volunteer cyclist bicycles,

788 00:41:38.710 --> 00:41:42.253 planning to volunteer cyclist or public bicycles.

789 00:41:43.180 --> 00:41:45.540 So and then, the smart sensor

790 00:41:45.540 --> 00:41:47.660 would sense the environmental conditions

791 00:41:47.660 --> 00:41:49.620 temperature humidity and in the future,

792 00:41:49.620 --> 00:41:52.510 we also want to measure air pollutants

793 00:41:52.510 --> 00:41:56.480 and so the sense of what, then you turn a cyclist smartphone

794 00:41:56.480 --> 00:41:58.440 into some kind of geolocation

795 00:41:58.440 --> 00:42:01.330 and data collection device and that data can then try

796 00:42:01.330 --> 00:42:05.130 and get transmitted to some kind of a server to allow

797 00:42:05.130 --> 00:42:08.330 and then in the case of public bicycles

798 00:42:08.330 --> 00:42:12.000 the data will be automatically transmitted to a data server,

799 00:42:12.000 --> 00:42:13.020 and then the data server

800 00:42:13.020 --> 00:42:16.500 would then dispatch data to different users

801 00:42:17.750 --> 00:42:19.600 and so that's the idea.

802 00:42:19.600 --> 00:42:22.140 So we are having some success

803 00:42:22.140 --> 00:42:25.240 in terms of designing a sensor,

804 00:42:25.240 --> 00:42:27.150 a smart sensor for temperature humidity.

805 00:42:27.150 --> 00:42:31.630 This is a patch of smart temperature humidity sensors,

806 00:42:31.630 --> 00:42:33.870 very small and this is a picture

807 00:42:33.870 --> 00:42:36.519 of all this smart sensors

808 00:42:36.519 --> 00:42:40.493 calibrate it against commercial sensors right?

809 00:42:41.489 --> 00:42:42.322 (indistinct)

810 00:42:42.322 --> 00:42:43.160 This is, oh sorry.

811 00:42:43.160 --> 00:42:45.080 Before I share with you some data,

812 00:42:45.080 --> 00:42:47.170 this is the kind of sensor right?

813 00:42:47.170 --> 00:42:48.200 It's very small

814 00:42:48.200 --> 00:42:51.560 or this is the interface, smartphone interface

815 00:42:51.560 --> 00:42:54.300 and this is to give you a scale of the sensor,

816 00:42:54.300 --> 00:42:57.600 a cache to the bicycle handlebar

817 00:42:57.600 --> 00:42:59.780 and so I'll show you that the idea we have

818 00:42:59.780 --> 00:43:01.738 is to recruit volunteer cyclists

819 00:43:01.738 --> 00:43:04.770 and eventually we can also implement sensors

820 00:43:05.972 --> 00:43:07.130 on public bicycles

821 00:43:07.130 --> 00:43:08.700 but in case of volunteer cyclists

822 00:43:08.700 --> 00:43:09.533 we are hoping,

823 00:43:09.533 --> 00:43:12.030 we are defining sort of kind of data interface.

824 00:43:12.030 --> 00:43:15.950 This is work by TC and Yichen interface

825 00:43:15.950 --> 00:43:18.810 to so that when the data is sent

826 00:43:18.810 --> 00:43:21.543 to some kind of data center,

827 00:43:21.543 --> 00:43:25.970 the cyclist would receive a link.

828 00:43:25.970 --> 00:43:30.030 The link then allows the cyclist to view the bicycle route

829 00:43:30.030 --> 00:43:33.780 as well as the conditions, temperature condition

830 00:43:33.780 --> 00:43:35.730 and humidity and maybe in the future

831 00:43:35.730 --> 00:43:40.730 also air quality parameters and along the route by spiked

832 00:43:40.890 --> 00:43:42.750 we are still having trouble with the color scale yet

833 00:43:42.750 --> 00:43:44.974 but if this is the kind of general idea, right?

834 00:43:44.974 --> 00:43:48.370 And so you can actually look at data, put the data

835 00:43:48.370 --> 00:43:52.480 this kind of spaghetti plot under different map background.

836 00:43:52.480 --> 00:43:54.990 This is just pure simple map background.

837 00:43:54.990 --> 00:43:56.800 You can put it in a,

838 00:43:56.800 --> 00:43:59.440 you know, satellite background map background

839 00:43:59.440 --> 00:44:03.020 or you can put down in street map background.

840 00:44:03.020 --> 00:44:07.420 So this is not place still very much a work in progress.

841 00:44:07.420 --> 00:44:10.630 So I was up here and see if we have questions.

842 00:44:10.630 --> 00:44:13.723 I like leave some time to engage.

843 00:44:13.723 --> 00:44:17.360 I was discussion and questions.

844 00:44:17.360 --> 00:44:18.360 Thank you very much.

845 00:44:19.680 --> 00:44:24.570 - Thank you, (indistinct) for the wonderful presentation.

846 00:44:24.570 --> 00:44:28.680 We do have a lot of questions from the students.

847 00:44:28.680 --> 00:44:31.490 But if people,

848 00:44:31.490 --> 00:44:33.610 if you have your own questions

849 00:44:33.610 --> 00:44:37.550 please type your question in the chat box while

850 00:44:39.150 --> 00:44:42.300 Dr. Lee was answering to the students' questions.

851 00:44:42.300 --> 00:44:44.340 So the first question actually

852 00:44:45.510 --> 00:44:48.450 don't be you showed a very very interesting

853 00:44:48.450 --> 00:44:52.680 with us about them, why the core roofs

854 00:44:52.680 --> 00:44:54.240 and I had receive a lot

855 00:44:54.240 --> 00:44:59.240 of question from the students asking about the comparison

856 00:44:59.470 --> 00:45:03.550 between a white roof versus a green roof.

857 00:45:03.550 --> 00:45:07.822 They were particular interesting in whether,

858 00:45:07.822 --> 00:45:11.370 what do you think about like the disadvantage

859 00:45:11.370 --> 00:45:15.183 of the white roof compared to the green roof?

860 00:45:16.080 --> 00:45:18.653 - So my White roof is not very pleasant, right?

861 00:45:18.653 --> 00:45:21.147 You don't like that in your neighborhood

862 00:45:21.147 --> 00:45:25.000 and if I showed you with that, a drone sort of animation

863 00:45:25.000 --> 00:45:28.470 the landscape's not that pleasant to look at

864 00:45:28.470 --> 00:45:31.360 but in terms of cooling this surface climate,

865 00:45:31.360 --> 00:45:33.740 white roof is much much more effective than green roof.

866 00:45:33.740 --> 00:45:36.613 I'll tell you why, in green roof, you have to,

867 00:45:38.433 --> 00:45:40.900 first of all, it's very difficult to plant trees

868 00:45:40.900 --> 00:45:42.993 on a roof right?

869 00:45:43.958 --> 00:45:47.460 So trees tend to sustain evaporation much more

870 00:45:48.879 --> 00:45:50.360 than grass than shrubs

871 00:45:50.360 --> 00:45:52.740 and so, but if you just planted shrubs

872 00:45:52.740 --> 00:45:57.057 and grass on rooftop, you have to constantly irrigate them

873 00:45:58.000 --> 00:45:59.857 in order to get cooling benefit

874 00:45:59.857 --> 00:46:02.230 and then your irrigation is not easy

875 00:46:02.230 --> 00:46:04.300 especially if you have a tall buildings

876 00:46:04.300 --> 00:46:05.900 and think about pumping water

877 00:46:05.900 --> 00:46:08.350 up to the rooftop and irrigate right?

878 00:46:08.350 --> 00:46:13.103 So that's itself is a very energy intensive endeavor.

879 00:46:14.400 --> 00:46:19.400 So absence of the radiation green roof really won't do much

880 00:46:21.061 --> 00:46:23.314 to the local temperature

881 00:46:23.314 --> 00:46:25.940 but I should have knowledge of obviously green roof

882 00:46:25.940 --> 00:46:27.580 is much more pleasant right?

883 00:46:27.580 --> 00:46:30.020 It's maybe has other benefits

884 00:46:30.880 --> 00:46:33.370 beyond just cooling the local landscape.

885 00:46:33.370 --> 00:46:37.520 So that's a debate obviously that's people should,

886 00:46:37.520 --> 00:46:40.882 that aspect should be considered

887 00:46:40.882 --> 00:46:44.250 when you look at a white roof versus a green roof.

888 00:46:44.250 --> 00:46:48.640 So if you look at the cooling power street vegetation

889 00:46:48.640 --> 00:46:49.490 is more effective

890 00:46:50.680 --> 00:46:52.090 than green roof.

891 00:46:52.090 --> 00:46:53.500 So you've put green roof here,

892 00:46:53.500 --> 00:46:57.793 the effect is really tiny compared to a quarrel for white.

893 00:47:00.800 --> 00:47:03.080 - Thanks, I think we will get more questions

894 00:47:03.080 --> 00:47:04.460 on these from the audience,

895 00:47:04.460 --> 00:47:08.950 but I will move on to the other question from the students.

896 00:47:08.950 --> 00:47:12.770 The other questions students are wondering is like

897 00:47:12.770 --> 00:47:17.330 you introduce us about the concept of urban heat Island

898 00:47:17.330 --> 00:47:21.720 and students are wondering like a lot of the mitigations

899 00:47:21.720 --> 00:47:26.270 we take for the urban area that's that has also impact

900 00:47:26.270 --> 00:47:29.040 for the adjacent rural areas.

901 00:47:29.040 --> 00:47:32.090 Like if we do all these,

902 00:47:32.090 --> 00:47:32.923 why move

903 00:47:34.200 --> 00:47:35.740 in urban area,

904 00:47:35.740 --> 00:47:38.230 does it also like

905 00:47:38.230 --> 00:47:40.310 simultaneously reduce

906 00:47:41.310 --> 00:47:43.683 the heat exposure in the rural area?

907 00:47:44.660 --> 00:47:46.120 - Yeah, that's a very good question.

908 00:47:46.120 --> 00:47:49.690 I think, so that really the question maybe can be brought

909 00:47:49.690 --> 00:47:53.740 in a little bit to say that's changing urban forms

910 00:47:55.000 --> 00:47:57.070 whatever way does the have effect

911 00:47:57.070 --> 00:47:59.720 on regional climate or even global climate?

912 00:47:59.720 --> 00:48:00.560 Right?

913 00:48:00.560 --> 00:48:02.420 The answer is probably no,

914 00:48:02.420 --> 00:48:06.670 because we are we are talking about change,

915 00:48:06.670 --> 00:48:08.220 intensive changes that's

916 00:48:08.220 --> 00:48:11.127 but the intensive change,

917 00:48:11.127 --> 00:48:16.127 is only occurs in a very tiny fraction of the landscape.

918 00:48:16.570 --> 00:48:20.550 Urban land is what 2% of the whole terrestrial land surface

919 00:48:20.550 --> 00:48:25.036 and so, and in that we have intensive modification

920 00:48:25.036 --> 00:48:27.640 that intensive modification will manifest itself

921 00:48:28.899 --> 00:48:32.880 in localized response but outside of urban area

922 00:48:32.880 --> 00:48:36.123 that the benefit is really really not that bad.

923 00:48:38.070 --> 00:48:39.863 So the answer is probably, no,

924 00:48:41.570 --> 00:48:45.500 unless we are dealing with like a huge metropolitan region

925 00:48:45.500 --> 00:48:50.000 maybe in India, where you have clusters of cities,

926 00:48:50.000 --> 00:48:52.180 a lot of cities cluster together

927 00:48:52.180 --> 00:48:54.740 maybe then there, you might have some effect

928 00:48:54.740 --> 00:48:56.333 on background temperature.

929 00:48:58.770 --> 00:49:00.830 - Thanks, I think, yeah.

930 00:49:00.830 --> 00:49:03.200 I think if we got a follow up customer

931 00:49:03.200 --> 00:49:05.110 regarding the green roofs

932 00:49:05.110 --> 00:49:07.483 so they were asking one of your paper,

933 00:49:08.756 --> 00:49:10.523 The Jaw and The Shoes article,

934 00:49:12.160 --> 00:49:14.790 in that paper, there's mixed implementation

935 00:49:16.103 --> 00:49:17.800 of the white and green roofs

936 00:49:17.800 --> 00:49:20.280 and the given the green roofs lead

937 00:49:20.280 --> 00:49:22.350 to increase the evaporation

938 00:49:22.350 --> 00:49:25.720 and likely increase humidity with wide roofs

939 00:49:25.720 --> 00:49:28.510 and green roofs have under

940 00:49:30.106 --> 00:49:31.320 donor's state effects

941 00:49:31.320 --> 00:49:35.970 due to green roofs contributing to the Web-bulb temperature

942 00:49:35.970 --> 00:49:38.900 - Yeah, yeah, that's an excellent point

943 00:49:38.900 --> 00:49:43.030 and so if you take that humidity into consideration

944 00:49:43.030 --> 00:49:44.430 you probably don't actually,

945 00:49:45.934 --> 00:49:50.050 you want to avoid a green roof

946 00:49:50.050 --> 00:49:50.970 because green roof

947 00:49:52.590 --> 00:49:55.470 on one hand you will reduce the air temperature.

948 00:49:55.470 --> 00:49:59.780 but on the other hand, it will increase humidity, right?

949 00:49:59.780 --> 00:50:03.290 So the reduction air temperature could be totally erased

950 00:50:03.290 --> 00:50:06.070 or the effect of temperature reduction could totally raise

951 00:50:06.070 --> 00:50:08.910 by enhanced humidity factors.

952 00:50:08.910 --> 00:50:12.430 And so, and of course in this analysis,

953 00:50:12.430 --> 00:50:14.710 the solid dollar analysis

954 00:50:14.710 --> 00:50:18.070 we have not brought in the concept of wet bulb,

955 00:50:18.070 --> 00:50:20.150 but if we bring wet bulb into consideration

956 00:50:20.150 --> 00:50:23.133 that may be an argument we should consider seriously.

957 00:50:24.896 --> 00:50:27.180 - Yeah, I'll also from the audience

958 00:50:27.180 --> 00:50:30.823 a question regarding the implementing of the

959 00:50:32.119 --> 00:50:34.450 core roof policy,

960 00:50:34.450 --> 00:50:38.140 have you considered whether you paint all the roofs white

961 00:50:38.140 --> 00:50:41.367 or use how they are scattered

962 00:50:41.367 --> 00:50:43.710 painting within the city?

963 00:50:43.710 --> 00:50:47.770 So do you consider the difference of the painting

964 00:50:47.770 --> 00:50:52.270 depend all the buildings, all you does a scattered because.

965 00:50:52.270 --> 00:50:57.270 - So in this calculation, we except hypothetical calculation

966 00:50:57.370 --> 00:51:02.370 we just combine all the routes to a high Albedo material,

967 00:51:03.400 --> 00:51:06.410 in actual implementation I think you cannot do that

968 00:51:06.410 --> 00:51:08.980 because there's no point actually doing

969 00:51:08.980 --> 00:51:10.470 a one size fits all situation

970 00:51:10.470 --> 00:51:12.970 because if you have North facing roofs right,

971 00:51:12.970 --> 00:51:17.420 then the deflections doesn't doesn't matter as much

972 00:51:17.420 --> 00:51:18.350 I saw spacing roof.

973 00:51:18.350 --> 00:51:20.380 So maybe you need to differentiate North facing

974 00:51:20.380 --> 00:51:21.940 versus South facing roofs.

975 00:51:21.940 --> 00:51:23.000 In the city of Chicago,

976 00:51:23.000 --> 00:51:25.670 they actually have grades,

977 00:51:25.670 --> 00:51:28.060 if you have very steep roof, they ask you,

978 00:51:28.060 --> 00:51:30.600 they recommend certain kind of Albedo values

979 00:51:30.600 --> 00:51:33.230 when you have less steep roofs,

980 00:51:33.230 --> 00:51:34.720 they recommend other kind Albedo

981 00:51:34.720 --> 00:51:35.583 so he said,

982 00:51:38.381 --> 00:51:39.531 it's mixed of strategy.

983 00:51:42.040 --> 00:51:43.720 By now all lot of cities actually

984 00:51:43.720 --> 00:51:45.960 aggressively promoting spokes,

985 00:51:45.960 --> 00:51:48.403 those kinds of reflect humid roof materials.

986 00:51:50.230 --> 00:51:52.680 - Thanks, I guess the audience

987 00:51:52.680 --> 00:51:55.460 and the students are very interested in this topic though.

988 00:51:55.460 --> 00:51:57.767 They have accurately both the students

989 00:51:57.767 --> 00:52:00.530 and audience ask a question regarding

990 00:52:00.530 --> 00:52:02.020 have you ever considered

991 00:52:02.020 --> 00:52:05.290 all these heat Island mitigation matters?

992 00:52:05.290 --> 00:52:08.840 They may have some side effects on the air quality

993 00:52:08.840 --> 00:52:10.680 so how you

994 00:52:11.550 --> 00:52:13.663 kissing that in your own modeling?

995 00:52:14.750 --> 00:52:16.420 - Yeah, there's a...

996 00:52:17.310 --> 00:52:21.100 So people say maybe for white roof material implementation

997 00:52:21.100 --> 00:52:22.840 it's best to it in clean cities

998 00:52:22.840 --> 00:52:26.600 where there's no, air quality is not a big concern

999 00:52:26.600 --> 00:52:31.150 in progic cities When you put in a white roof,

1000 00:52:31.150 --> 00:52:32.500 you can change

1001 00:52:33.670 --> 00:52:37.260 the way that the structure of the boundary layer

1002 00:52:37.260 --> 00:52:39.870 essentially what happens is if you have a white roof

1003 00:52:39.870 --> 00:52:43.930 you are not heating the low atmosphere as much.

1004 00:52:43.930 --> 00:52:45.960 You're reflecting a lot of sunlight away

1005 00:52:45.960 --> 00:52:47.147 without us to the upper atmosphere

1006 00:52:47.147 --> 00:52:49.150 and to the outer space, right?

1007 00:52:49.150 --> 00:52:50.840 So what happens then is you end up

1008 00:52:50.840 --> 00:52:53.810 with a shallow a boundary layer

1009 00:52:53.810 --> 00:52:57.380 but there's less mixing power, less mixing volumes,

1010 00:52:57.380 --> 00:53:00.690 so you end up with higher air pollution concentration.

1011 00:53:00.690 --> 00:53:03.650 So that's the, it could be a serious societal effect

1012 00:53:03.650 --> 00:53:05.490 especially imploded seedlings.

1013 00:53:05.490 --> 00:53:06.973 So that's another,

1014 00:53:10.822 --> 00:53:12.922 this the harm you could say perhaps caused

1015 00:53:14.484 --> 00:53:16.050 by air quality.

1016 00:53:16.050 --> 00:53:17.300 That's a very good point.

1017 00:53:19.460 --> 00:53:24.460 - Thanks, another aspect of the students are wondering

1018 00:53:24.580 --> 00:53:27.556 is like you showed a little bit about

1019 00:53:27.556 --> 00:53:28.980 the different

1020 00:53:30.520 --> 00:53:32.330 like riddles from the satellite,

1021 00:53:32.330 --> 00:53:33.510 from the modeling

1022 00:53:33.510 --> 00:53:35.560 and the students are particularly interesting

1023 00:53:35.560 --> 00:53:38.670 in wanting these kind of modeling.

1024 00:53:38.670 --> 00:53:40.440 So how can you actually

1025 00:53:43.300 --> 00:53:45.430 simulate the interactions

1026 00:53:45.430 --> 00:53:50.430 with the global warming and also all the biophysical drivers

1027 00:53:51.320 --> 00:53:53.770 of the urban heat Island in the continent models?

1028 00:53:54.870 --> 00:53:57.730 - Okay, so in the climate models right,

1029 00:53:57.730 --> 00:54:00.180 they, a lot of models don't actually have

1030 00:54:00.180 --> 00:54:03.510 what we call a city landscape that so,

1031 00:54:03.510 --> 00:54:06.100 but the the model we use

1032 00:54:06.100 --> 00:54:09.240 have what we call subgrid parameterization,

1033 00:54:09.240 --> 00:54:10.920 so within each Greek cell

1034 00:54:11.850 --> 00:54:14.440 you have different parches for that type of land

1035 00:54:15.340 --> 00:54:18.080 so some great cells were contained

1036 00:54:19.630 --> 00:54:21.450 urban land tile, urban tile

1037 00:54:22.350 --> 00:54:25.580 and some would have no, if there's no urban.

1038 00:54:25.580 --> 00:54:28.570 So this model actually can calculate

1039 00:54:28.570 --> 00:54:33.120 within which is great cell, temperature, humidity,

1040 00:54:33.120 --> 00:54:36.483 and so on within for each tile.

1041 00:54:37.765 --> 00:54:41.280 So typically when you download a data though,

1042 00:54:41.280 --> 00:54:43.060 the data is aggregate to the Greek cell

1043 00:54:43.060 --> 00:54:47.750 that was so you don't see subgrade kind of a pattern.

1044 00:54:47.750 --> 00:54:50.270 You don't see a subgrade pattern

1045 00:54:50.270 --> 00:54:54.440 but we are able to re redo the calculation

1046 00:54:54.440 --> 00:54:58.570 and retrieve data within each Greek Model grade data

1047 00:54:58.570 --> 00:55:01.710 for vegetations tile and offer urban tile.

1048 00:55:01.710 --> 00:55:03.400 So that essentially set up the problem

1049 00:55:03.400 --> 00:55:05.980 for us to have to do then compare

1050 00:55:05.980 --> 00:55:08.820 those subgrade tile data to get the urban heat Island calc

1051 00:55:08.820 --> 00:55:10.820 apart from the climate models.

1052 00:55:10.820 --> 00:55:15.480 That's how a client model handles landscape heterogeneity

1053 00:55:15.480 --> 00:55:17.683 within a model grid cell.

1054 00:55:19.260 --> 00:55:22.410 - Thanks, I think due to the time limitation,

1055 00:55:22.410 --> 00:55:23.390 final question

1056 00:55:23.390 --> 00:55:26.620 is the students and audience are very interested that

1057 00:55:26.620 --> 00:55:30.560 in like, what's your recommendations for our daily life

1058 00:55:30.560 --> 00:55:32.240 in as an individual,

1059 00:55:32.240 --> 00:55:36.094 is it more eco-friendly to have solar panels

1060 00:55:36.094 --> 00:55:38.527 or have a quarter of a solar.

1061 00:55:39.365 --> 00:55:41.680 - Solar panels are very interesting, right?

1062 00:55:41.680 --> 00:55:42.730 You need to do a very

1063 00:55:43.955 --> 00:55:46.750 sort of a careful calculation,

1064 00:55:46.750 --> 00:55:47.680 to look at the benefits.

1065 00:55:47.680 --> 00:55:49.600 So solar panel dependent if it's true false

1066 00:55:49.600 --> 00:55:52.610 for why is that you, like I said

1067 00:55:52.610 --> 00:55:57.380 you convert a local solar radiation to electricity

1068 00:55:57.380 --> 00:56:01.386 and in doing so, you don't heat the environment,

1069 00:56:01.386 --> 00:56:03.910 you don't allow radiation to heat the environment

1070 00:56:03.910 --> 00:56:06.380 but the commercial efficiency is not very high.

1071 00:56:06.380 --> 00:56:10.550 It's not as high as reflection by core roof.

1072 00:56:10.550 --> 00:56:14.690 So on its own, you would say the cooling benefit

1073 00:56:14.690 --> 00:56:18.250 of solar panel is not as high as core roof,

1074 00:56:18.250 --> 00:56:20.970 but then you have an added benefit

1075 00:56:20.970 --> 00:56:24.030 of electricity generated by solar energy right?

1076 00:56:24.030 --> 00:56:24.863 So you

1077 00:56:26.720 --> 00:56:30.480 offset the demand for fossil fuel energy.

1078 00:56:30.480 --> 00:56:32.300 So that benefits more broad

1079 00:56:32.300 --> 00:56:35.520 modular views is you're offsetting energy demand

1080 00:56:35.520 --> 00:56:37.210 for fossil fuel

1081 00:56:37.210 --> 00:56:40.660 and therefore you cool the whole club global climate.

1082 00:56:40.660 --> 00:56:43.783 So there's that, there's a benefit to that

1083 00:56:43.783 --> 00:56:47.020 so that you need to consider both sides

1084 00:56:47.020 --> 00:56:49.600 local Coolig versus global cooling

1085 00:56:49.600 --> 00:56:51.940 versus and offsetting energy

1086 00:56:53.202 --> 00:56:56.070 and so that'd be a hard subject

1087 00:56:56.070 --> 00:56:57.653 that need to be debated, right?

1088 00:56:58.600 --> 00:56:59.595 But I think if you are,

1089 00:56:59.595 --> 00:57:03.150 if you want to conserve your electricity bill,

1090 00:57:03.150 --> 00:57:05.770 if you want to reduce your electricity bill in your house

1091 00:57:05.770 --> 00:57:06.603 that you're,

1092 00:57:06.603 --> 00:57:10.871 the best approach is actually having a core roof.

1093 00:57:10.871 --> 00:57:13.370 If you have at a core roof on your rooftop,

1094 00:57:13.370 --> 00:57:18.010 then the demand for AC will be substantially reduced.

1095 00:57:18.010 --> 00:57:22.650 You will have a lot of electricity saving in that way.

1096 00:57:22.650 --> 00:57:25.500 That's has to be demonstrated by a lot of people actually

1097 00:57:26.420 --> 00:57:27.610 - One fourth session.

1098 00:57:27.610 --> 00:57:30.610 Thank you for all the insightful discussion

1099 00:57:30.610 --> 00:57:32.830 and also the presentation

1100 00:57:32.830 --> 00:57:36.590 and with that, I think we thanked Dr. Lee

1101 00:57:36.590 --> 00:57:38.760 for this wonderful presentation

1102 00:57:38.760 --> 00:57:42.513 and I thank you all for coming for our seminar.

1103 00:57:43.540 --> 00:57:45.223 - Bye - See you guys.